City of Tigard

GIS Implementation Plan: GIS Solution

FINAL

August 2007

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City of Tigard
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EXECUTIVE SUMMARY

The City of Tigard is embarking on an exciting, challenging, and critical phase of its GIS development. Over a number of years, the City has built an excellent foundation for managing an enterprise Geographic Information System (GIS) to serve all City departments. They have invested in the basic GIS hardware and software to operate a system and have dedicated staff resources to GIS and to supporting business systems such as Hansen, Tidemark, and Springbrook. Furthermore, the City and its Council have approved a spending budget for GIS software acquisition and consultant projects. The City's GIS Coordinator has taken a leadership role in aligning Tigard with a holistic system that helps everyone with their job.

Like many other cities in the region and beyond, Tigard has had an operational GIS for many years; however, it is a legacy system that contains inconsistent and incomplete data and does not reflect the contemporary components and technologies of an enterprise GIS. There are several opportunities for improvement in the data, the software and technology, and the way people manage and use GIS data. This document is designed to take the requirements identified by the many users of GIS in the City and develop recommendations for actions and strategies that will allow the City to build on its GIS investment and to move forward in the most effective way possible.

OVERVIEW

We have organized our recommendations into four categories: Spatial Data; Organization and Support; Applications and Tools; and System Architecture. A vision statement formulated for each category highlights the collective aspirations of workshop participants for creating a high quality enterprise GIS that supports the business needs of the City. Also developed for each category are goals, projects and actions, gaps, and strategies. The success of Tigard's GIS depends on success within and among all four categories. For example, the spatial data and technical aspects of the system require full support at the organizational and management level. The recommendations speak to the foundation of the City's GIS and focus on developing projects and strategies that align with a long-term vision for the enterprise.

SPATIAL DATA

Attention to the creation and maintenance of spatial data is the most important element of Tigard's GIS. It is also the area that represents the greatest effort and challenges facing the City's GIS development. GIS users want access to spatial data with a high level of confidence that the information is complete and accurate. They want their daily business processes supported with spatial data that can be drawn to a map.

The greatest challenge to achieving this vision is the disconnect between business systems used by the City and the associated GIS data, notably Hansen for asset data management and work orders, Tidemark for permitting, and, to a lesser degree, the Springbrook utility management and billing system. Creation and management of data in these systems must be done simultaneously with update of associated GIS layers. In the case of Hansen, there are tools to initiate a record in Hansen using GIS.

Spatial data must be reconciled via specific managed projects. Some projects should be done internally; however, more complicated projects may require consultant assistance. Recommended projects include:

- Data Development Protocols, including a Spatial Data Management Program as well as tools and protocols for developing new and modifying existing data.
- A Geodatabase Design that logically organizes spatial data for easy access via a GIS map.

- A Data Documentation process that tells users what the data is, how it is used, and when it was created.
- Deployment of Data Projects for addresses; water, storm, and sewer utilities; streets; and water meters and billing.

ORGANIZATION AND SUPPORT

Organization and support are necessary to keep GIS working effectively in the City, now and in the future. The GIS Coordinator and GIS Steering Committee will continue to work together to develop annual work plans and project budgets. Roles will be identified and responsibilities for management of GIS data will be delegated.

Of concern is adequate staffing and related support for the City's GIS. Current staffing levels are not enough to meet all the GIS goals. Existing staff must also be trained for specialized duties. As a smaller City, Tigard will benefit from lower costs in data development and data maintenance. However, in the areas of GIS management and support, many of the required GIS-related roles and responsibilities are the same as a larger organization, thereby setting a base level for staffing costs that is relatively high. Some things, such as development, can be contracted externally. Other tasks and responsibilities, such as spatial data management or system administration, must be carefully thought out and assigned. In a smaller agency, roles may be shared. The most important thing to do is acknowledge what is needed and make sure the roles and responsibilities are clearly understood and managed.

Building the Tigard "GIS Team" requires leadership from the GIS Coordinator and department heads. The Team should include the following roles and responsibilities:

- GIS Coordinator (already in place)—Lead the GIS effort at the City, handle complex tasks, and head the Steering Committee.
- Spatial Data Administrator (currently the GIS Coordinator)—Design and manage the City's corporate geodatabases, data standards, and metadata.
- Hansen Administrator (in process of hiring)—Coordinate and ensure maintenance of Hansen database.
- GIS System Administrator (currently the GIS Coordinator)—In charge of the overall system architecture and administration of GIS software and technologies.
- GIS Developer (likely to be consultant support)—Design and build applications to manage and deploy GIS at the City.
- Lead GIS Analyst (currently filled by several City staff)—Conduct complex analyses and directly support departmental GIS analysts.
- Departmental GIS Analysts (currently filled by several City staff)—Coordinate GIS for specific departments, including helping to conduct analyses for other professionals working in the departments.
- Departmental Spatial Data Stewards (currently unfilled)—Coordinate and perform regular maintenance on specific corporate data layers within the City.

Governance over the City's GIS must be established and coordinated through the Steering Committee, technical working groups, department leadership, and the City Council.

APPLICATIONS AND TOOLS

Applications and tools provide the means to use and manage the enterprise GIS data throughout the City. They bring GIS to end-users, including the desktops of City staff, mobile staff, and the public. For this reason, as well as for long-term maintenance and sustainability, it is crucial that applications be developed within a solid system architecture with clear standards; they should also be designed for sustainability and reusability. Figure ES-1 presents the relationships among the key applications and tools for the City's GIS.

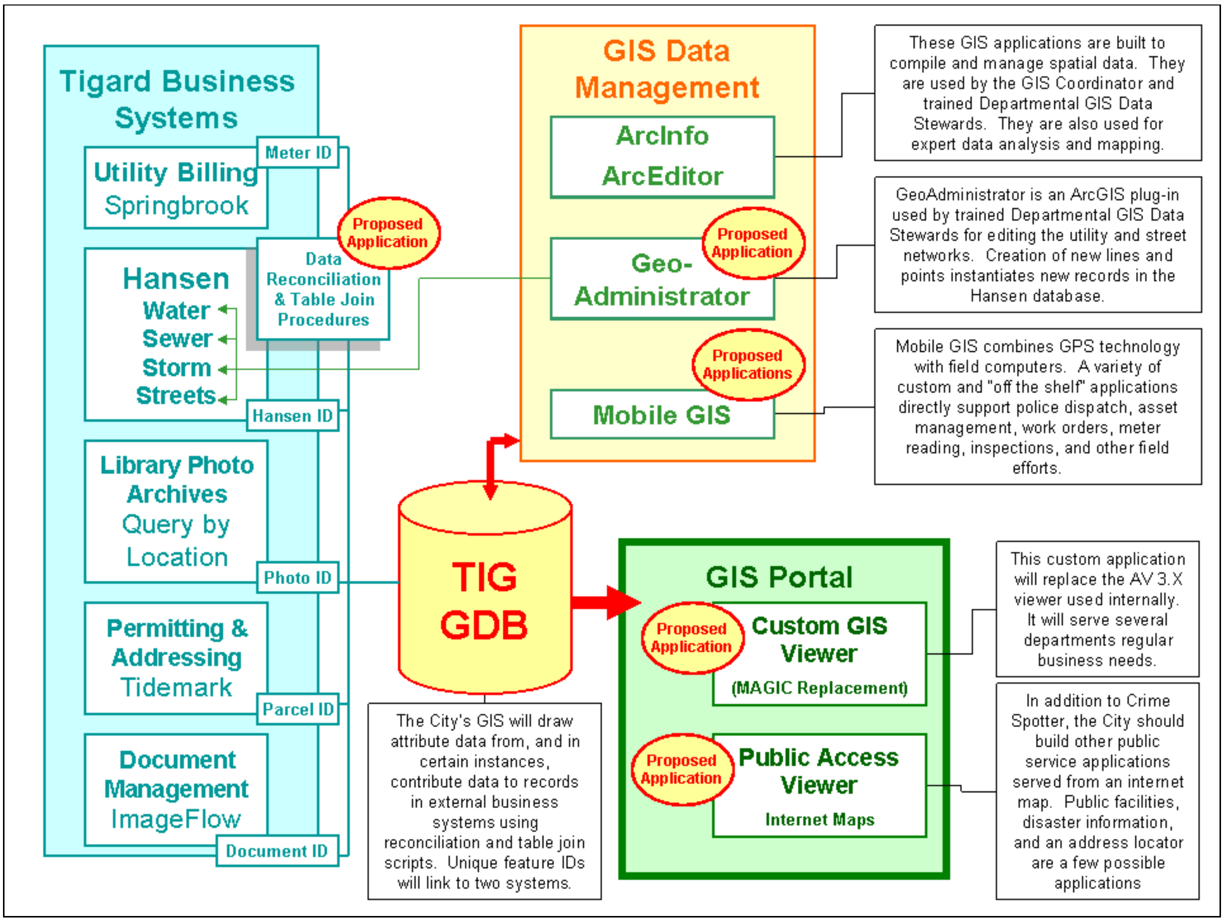

Figure ES-1. Tigard GIS Applications and Tools

The greatest challenge to developing these applications is meeting the goals for Spatial Data and Organization and Support. ***The applications will not be effective without good data and a formal organization of GIS data managers, analysts, and stewards***.

The following major application projects are recommended:

- **MAGIC Replacement**—Develop a city-wide application, or combination of applications, that replaces MAGIC functionality, using newer platforms, software, and programming languages. MAGIC is based on old technology and programming languages. Newer applications are likely to start with a richer set of functionality and include much of MAGIC's "customized functionality" out-of-the-box. Thus, the replacement can greatly improve functionality available to staff with minimal work. The focus should be on making the applications widely available to all types of users (e.g., desktop, mobile) and providing improved functionality, such as advanced querying, reporting tools, and mark-up tools to improve the usefulness of the application. Additionally, integration with other business systems, as noted below, should be designed into the new application(s) to create a seamless and comprehensive interface to the City's information systems.

- **Hansen Integration**—Of vital importance to the City's Public Works Department will be the ability of the enterprise GIS to integrate with the City's asset management and work order system Hansen. This should include query and reporting functionality that allows an end-user to perform various spatial queries, hitting both GIS and Hansen from a map environment. Editing tools will be especially important due to the complex nature between maintaining ID structures between Hansen and GIS There are some "out-of-box" solutions provided by Hansen that can help provide reconciliation between GIS and Hansen. Other integration, such as creating desktop applications that allow querying and reporting of Hansen information through GIS will involve adapting to and integrating with the Hansen database schema and complying with specific Hansen requirements. It is recommended that scripts be created for reconciling differences between Hansen and GIS, as well as scripts that join Hansen attributes to the GIS tables.
- **Enterprise GIS in the Field**—Of critical importance for a City with employees working in the field will be extending the enterprise GIS in the field. This includes police vehicles, utility workers, inspectors, meter readers, and other mobile staff. There are several field applications that employ GPS and GIS to map the location of features, to assist in locating assets, managing utilities, conducting in-the-field mapping, and creating or implementing work orders. It will be important to determine the level of editing capabilities with the different business systems, if GIS in the field is to be a robust and fully capable tool. In-the-field GIS should extend to onboard computers in police vehicles, which can be equipped to provide locational and navigational information to assist officers with locating spatial information while in the field.
- **Integration with Springbrook and Tidemark (Accela)—**applications should be built to map information from these systems using a GIS viewer.
- **Document Management and GIS**—The City is moving forward with purchasing and implementing a city-wide document management system (DMS). There is a strong desire to be able to integrate GIS with a DMS to tie documents to a location and thus view a location and its associated documents, or search documents and view its associated location. It is recommended that access to documents be as seamless as possible for the end-user (i.e., fewest amount of clicks) and be accessible via the GIS or via the DMS. One potential use identified during the needs assessment was being able to tie historical photos in the library to a map environment. This could serve as a good test project for DMS and GIS.
- **Police Command and Control**—The City's Police Department must align itself with technology innovations in homeland security and public safety. Although Tigard Police are successfully using in-vehicle navigational maps from Portland Police, there are several opportunities to improve map detail and geocoding using the City's GIS layers. By using the City's parcel, street, address and aerial photo layers, in-vehicle maps will provide more local detail for responding officers and offer avenues for more efficient response to 911 calls from cell phones. Recent technologies in wireless map services should be investigated. Stationary GIS map engines can render "live maps," including officer and call locations at regular brief time intervals (10 to 20 seconds) and serve them wirelessly to vehicles. There are consulting firms that specialize in GIS-based command and control systems.

- **Crime Analysis Query and Reporting**—The Police Department has access to several large databases. In addition, there are custom applications provided by other agencies. However, these still contain shortcomings and don't have the flexibility for continually changing customized queries resulting in mapped products. Flexible querying and reporting functionality of the City's GIS applications needs to be incorporated into the design.
- **GIS Portal—**One of the goals of the enterprise GIS is ease of access. Given the robustness of the planned system, it is recommended that a GIS Portal, or front-end, be developed in order to create a "one-stop shopping" entry for users accessing spatial data. A portal should offer access to the main enterprise applications, specific applications, a common query entry, links to other GIS-related sites, training links, FAQS, links to metadata, help, etc.
- **Public Access to GIS**—Using a concept similar to the GIS portal, the City should develop a single point of entry for spatial data available to the public. Ease of access is even more important for a public portal, given the likelihood of casual users. The City has already developed a pilot project being used by the public (CRIME Spotter), which can serve as a basis for further development Other elements identified in the GIS portal can also be used in the public access portal.

SYSTEM ARCHITECTURE

System architecture provides the base which, ideally, makes the technology challenges in GIS invisible to the users. It supports development, data access, system integration, and high performance. The infrastructure and architecture in Tigard will create the best possible working environment for GIS users, including optimal software, applications, and performance. It will start with sound Geodatabase organization and design. Tigard's asset management and work order system (Hansen), financial system/water billing system (Springbrook), and permitting system (Tidemark (Accela)) will continue to be primary repositories for address, asset, billing, and permitting data, with the information readily available via GIS.

The challenge with system interoperability and GIS is limited, or no, vendor support. To achieve the goals of creating applications, the City will have to engage in some level of custom application development. This takes more time and money for development, but will yield a greater benefit in the long term.

Solutions begin with creating an Administrator's interface for managing user accounts, delegating file editing permissions, and running the enterprise GIS viewer. Projects targeting interoperability with business systems require the support of consultants and vendors. All applications should be built upon industry standard components using common development environments.

CHAPTER 1.
VISION

The overall vision for Tigard's GIS, as seen by the internal customers, is clear. They envision a GIS that effectively supports their priority business activities with high quality data, tools, support, and integration with business systems. The GIS supports a broad array of users, from the casual map viewer to the skilled analyst. GIS use will continue to grow in Tigard, presenting a need to serve many more people with simple and consistent GIS tools. Achieving the vision presents many challenges. It will require departments working together to set priorities and to create strategies and projects that can make the vision a reality over time. More detailed vision in key areas begins to clarify directions for the planning and implementation processes.

SPATIAL DATA

Data and information management is the key to Tigard's success in GIS. The data in the GIS will be up-to-date, reliable, and well-managed in a corporate Geodatabase. Use of the information will be supported by documentation that is concise and easily accessible by all staff. Users will have access to data created within Tigard, as well as regional data from RLIS, Washington County, and other data sources external to the City. Information management and access will be made easier by the availability of tools and processes that assist and guide staff. Roles and responsibilities for spatial data entry and management will be shared among departmental data stewards and guided by the GIS Coordinator.

ORGANIZATION AND SUPPORT

The GIS Steering Committee will work closely with the GIS Coordinator to develop yearly work plans and funding strategies for GIS that accommodate changing needs and new users. Core GIS functions, such as viewing, research, spatial data management and support, will be funded. The GIS Steering Committee will actively communicate with GIS users about funding, projects, system upgrades, training, and other significant issues. All levels of GIS users (e.g., power users, casual users) will have access to training and support and will understand the roles and responsibilities associated with those functions.

APPLICATIONS AND TOOLS

A desktop replacement for MAGIC will be created and made available to all GIS users. The design of this application will begin with a thorough assessment of user needs and ensure that the desired functionality from MAGIC is duplicated and that new functionality is added. The application will have enhanced mapping capabilities and access to the most current information in the corporate GIS data set. This application will support many of the everyday research and mapping needs of the Tigard staff for GIS. The application design will take into account the overall GIS architecture and ESRI software directions, to ensure long-term success. Individual business priorities in each department, including field needs and other special requirements, will be supported by additional GIS projects that are coordinated within Information Technology and fit with departmental standards and work plans.

SYSTEM ARCHITECTURE

The infrastructure and architecture in Tigard will create the best possible working environment for GIS users, including optimal software, applications, and performance. It will start with sound Geodatabase organization and design. The Geodatabase(s) will be sensibly organized for spatial data management and deployment. To simplify data management, replication of layers will be avoided. Themes will be logically organized into spatial data categories that are thematic rather than by business area (for example, buildings will be organized into the "infrastructure" dataset rather than "disaster management"). The Geodatabase will have strict controls for editing. Protocols for creating and managing data will be documented.

Tigard's asset management and work order system (Hansen), financial system/water billing system (Springbrook), and permitting system (Tidemark (Accela)) will continue to be primary repositories for address, asset, billing and permitting data, with the information readily available via GIS. The connections between Hansen and GIS will be streamlined and, as much as possible, appear seamless to GIS users. GIS will be integrated, where possible, into the daily business of Tigard and support departmental priorities for land use planning; asset management and maintenance; police; disaster planning and response; and other City services. In addition, GIS will be used as a tool to support a high level of service for the public, via public counters and, in the future, the Internet.

CHAPTER 2.
RECOMMENDATIONS

INTRODUCTION

The GIS vision statements provided an excellent foundation for developing the following series of recommendations for actions, and strategies that will support the business needs for GIS at the City of Tigard now and in the future. The recommendations for GIS development and management in Tigard reflect the user requirements identified in the GIS Needs study. The needs were synthesized into a Vision for GIS at the City and the recommendations use that vision to build goals, actions, and strategies. Business goals are important because they allow us to identify why we are taking the recommended actions or creating specific projects. Strategies provide ideas on how we can support the actions through initiatives and approaches at a higher level. Areas of concern, where there are significant differences (or gaps) between the goals and the existing situation are also identified. These gaps provide an idea of how difficult, and also how costly, implementation and maintenance of the recommendations might be.

Spatial data is addressed first, since it is the foundation of overall GIS development at the City. Without access to quality data, the GIS will not succeed. Data management is the key to maintaining that foundation over the long run. Organization and support, including governance, keep the system alive and growing. GIS is never “done”; it is a long-term investment that requires a program of staffing and governance to ensure that things are done in a systematic and supported environment. The applications are specific technical solutions to identified problems. These applications must fit within the system architecture standards for the City’s GIS. Applications must also be well designed and maintained. The recommendations for system architecture will be high level. More detailed work is being done in a further contract. There is overlap among the four different areas. The overlap shows how GIS is truly a system; all the components need to work in concert to ensure success.

SPATIAL DATA

The creation, maintenance, and management of high quality and complete spatial data are the cornerstone of this assessment and of the success of Tigard’s GIS. *As a supplement to this document, the Data Assessment document formulates a detailed list of spatial layers that are managed by the City, including a prioritization of data-specific projects and routine maintenance procedures.*

Recommendations related to spatial data prepare the City for a successful GIS deployment by meeting the basic business requirements within the City. They include opportunities in a.) creating new data, b.) enhancing or modifying existing data sets, c.), organizing data sets to avoid replication and multi-copies, and d.) sharing data with external agencies where possible. Once standards for these data opportunities exist, the City is on the road toward a deployable GIS. Opportunities for long-term maintenance and management of spatial data are discussed in the following section, *Organization and Support.*

Goals

Goals related to Spatial Data are paramount to the successful use of GIS at the City:

- Support business workflows and applications with accurate and complete spatial data.
- Data will be easily accessed and consumed.
- Business Data in Hansen, Springbrook, and Tidemark will be easily viewed via a GIS map.

- The City will continue to share data with regional data providers.

Projects and Actions

The overall success of GIS at the City relies upon the following data projects. The projects will involve the following elements:

- The City will create new spatial data for high-priority data sets in accordance with standards and procedures. These include digitizing features using the proper base map or field inventory using high-accuracy GPS and create data schemas that interoperate with existing business systems and directly support regular business functions.
- Existing high-priority data sets will be enhanced to 1) Interoperate with existing business systems, 2) Be as complete as possible to avoid map gaps, and 3) Provide missing attribute information that directly supports regular business functions.
- Organization of all spatial data owned by the City will be in a secure Geodatabase environment that is made available to all City staff via enterprise GIS tools and applications. Each feature class managed by the City will have associated metadata. The data will reflect the “state-of-the-art” versions and will only allow write-access to authenticated “power users.”
- The City will continue to rely on partner agencies responsible for managing data (notably Portland Metro and Washington County) while making available its own data to these agencies.

Data Development Procedures

Data development procedures must include two elements:

- The creation of a *Spatial Data Management Program* that engages staff and external support to manage information.
- The prescription of technologies and procedures to establish a framework for creating new and modifying existing data.

The Spatial Data Management Program must designate staff and resources for daily spatial data management. This is a critical element and is covered in more detail in the recommendations for *Organization and Support*.

The City of Tigard should create written procedures for creating new data or spatially modifying existing data. This should include the adoption of a preferred ***Base Map*** for the *creation of new data* and the *modification of existing data*. The *Base Map* is the map surface on which geodetic control is situated. *Together with high-accuracy GPS equipment, the base map establishes a foundation for spatial precision and accuracy*. This control includes map layers that define spatial units and location parameters for building and modifying map data. It is the control document from which other data layers in the GIS are developed. The base map will reside in the GIS and consist of the most recent aerial photography, cadastral information, planimetric information where available (the physical identification of structures, roads, and other surface infrastructure), and include reference grids commonly used by the City (address grid and/or stateplane). The City’s previous investment in control points for its cadastre (created and managed by the Washington County Tax Assessor, has greatly enhanced the base map accuracy and should be leveraged for future data development projects.

The best commercially available GPS receivers are real-time kinematic (RTK). When used with a base station and minimal canopy interference, point features can be located with centimeter accuracy. The

RTK becomes especially useful in utility inventory where vertical accuracy is paramount. For about one third of the cost of RTK equipment, mapping grade GPS can attain one-to-three foot horizontal accuracy.

The City currently does not own a roving GPS unit. *It is recommended that the City invests in at least one high-accuracy unit for routine locating of features in the field.*

The base map is the foundation for most data development practice. However, field inventory techniques using GPS are favorable. Following is the hierarchy of preferred inventory techniques:

1. Real Time Kinematic (RTK) GPS (centimeter accuracy)
2. Mapping-Grade GPS (1-3 foot accuracy)
3. Digitize over a base map (aerial photography most critical)

Geodatabase Design

A recommended high-level Geodatabase design is provided to the City as a part of this GIS Needs Assessment Project. This design will help avoid duplicate storage of features and streamline data retrieval. However, the City will have to follow-up by creating detailed feature dataset and feature class schemas that a.) outline required data fields, preferred subtypes, and coded domains consistent with the business requirements, b.) define topologies amongst layers within feature datasets as necessary, and c.) establish feature identification schemas to link to external business systems. These detailed Geodatabase designs must proceed the creation and/or modification of layers as well as the importation of features into the Geodatabase. A detailed design for the water system is included in this project. Designs for other feature datasets must be conducted by the City and/or consultant support in an interactive workshop format. The designs require not only an understanding of the ESRI design logic but a detailed understanding of the real world constructs and relationships of the features. City staff brings forth an important understanding of the systems that must be modeled in a Geodatabase.

Data Documentation

Each GIS layer must be documented with metadata. Metadata provides both general and technical information about the dataset. It is important the City establishes a minimum needs guideline for adding metadata to each feature class, and place a high priority on everyone involved in creating and using the layer to assist in documentation.

The metadata for GIS file data can be managed using the ArcCatalog Metadata tools on the Metadata toolbar, or another FGDC-compliant metadata software. The minimum needs for a city data file may include any or all of the following pieces of information: unique identification, description, content, purpose, status, accessibility, creator, publisher, data quality, condition, spatial data organization, spatial reference, entity and attribute descriptions, distribution, and/or metadata reference information. A chart that displays a sample set of minimum metadata format should be provided to Data Stewards. Table 1 lists the specific FGDC fields that should be completed. Other fields are optional.

TABLE 1.
METADATA FIELDS TO BE COMPLETED FOR GIS FILE DATA

A. Description Fields
   1. Abstract
   2. Purpose
   3. Status of the Data
      a. Completeness
      b. Data update frequency
   4. Time Period for which the Data is Relevant
   5. Data Storage and Access Information
      a. File Name
      b. File Type
      c. Location of the Data
   6. Document Details
      a. Date and Time of Last Update
   7. Who Completed This Document

B. Spatial
   8. Horizontal Coordinate System
   9. Bounding Coordinates (auto-filled)
   10. Lineage
      a. Process Step 1
      b. Process Step 2
      c. Process Step 3

C. Attributes
   11. Details
      a. Type of Object (auto-filled)
      b. Number of Records (auto-filled)
   12. Description
      a. Brief Description of Contents
      b. Data Source
   13. Attributes (database fields)
      a. Name
      b. Alias
      c. Data Type (auto-filled)
      d. Data Width (auto-filled)
      e. Definition
      f. Definition Source
      g. Data Value Domain (if applicable)
   14. Subtype Information (if applicable)
      a. Subtypes and Description
   15. Relationships to Other Objects
      a. Relationship Entity and Relationship Type

Data Project—Addresses

The City relies on addresses to serve a part of all business functions. In many cases, the address is a necessary part of the business function, for example:

- Emergency Response (to a home or other addressed facility)
- Crime Reporting, Analysis and Mapping
- Utility Billing and Water Meter Service
- Facilities Management
- Addressing New Units (during the permitting process)

In other cases, the City should rely less on addresses and more on GIS to locate features. Examples include:

- Location of Assets (non-addressed assets, bollards, street signs, trees, etc.)
- Utility Features (catch basins, manholes, water valves, hydrants, outfalls, etc.)
- Subdivisions and Plats

An important point is easing the reliance of addressing in Hansen. Asset inventory and work orders are better accompanied by a map than by a nearby address. A high quality address base can be used to view addresses and to “address match” to an approximate location without the need to attach an address to the asset.

The objective of the address project is to create a standardized master address database that a.) feeds dependent business systems, including the GIS point address layer, b.) reconciles inconsistencies in the way addresses are entered in dependent business systems, and c.) contributes to the regional system of street addressing, notably Portland Metro’s street geocoding layer.

The City should use GIS as the point of address creation, with a subsequent update and/or reconciliation of addresses in the other business systems. The master address database should a.) cover all geographic areas related to City functions, including the utility service areas, and b.) conform to the Oregon State Standard for Addressing. Addresses should represent discrete locations, including suites and multi-units on single properties.

First, the existing address layer in GIS should be cleaned based on the standardized addressing system. Addresses for peripheral utility service areas must be added. Protocols for creating new addresses must be documented. Finally, Addresses in Tidemark and Springbrook should be reconciled using the standardized formatting of the GIS address point layer.

Data Project—Water Infrastructure and Hansen

The Tigard water system is currently a mosaic of GIS lines and points, CAD drawings, and as-built drawings and images. Several water valves and hydrants were located using GPS in 1995. Although much of the existing data is viewable in MAGIC, it lacks a basic link to Hansen. Water system data is regular managed in Hansen, but preliminary inspection exposes much missing and inconsistently entered data.

The deployment of a water network project can be separated into SHORT-TERM and LONG-TERM opportunities. The short-term opportunities focus on fixes the City can make on the GIS layers and Hansen data to instantiate a basic interoperability of the two systems. Long-term opportunities seek opportunities for future ongoing management of these systems to avoid duplication of effort:

- Short Term (the short-term water system tasks will directly support improvements to the Hansen work order system for water):
  - **Assessment of Completeness**—The City should leverage the GIS data it already has, included the GPS locations of valves and hydrants from the 1995 survey. Missing data may be digitized from as-built drawings or converted from the CAD layers of water. Assessment of completeness for the GIS features must include service areas outside the City's boundary.
  - **Hansen Cleanup**—The Hansen data appears to be missing basic maintenance information, shut-off valve data, year built, and flow test information for several features. Some of this missing data must be retrieved from maintenance records and as-built drawings and hand entered into Hansen. An opportunity for this effort may reside in an upgrade to Hansen Version 8. At the time Hansen data is moved to the new version, the City must clean up the data as a part of a focused project.
  - **Create Water GIS Network Geometry**—The City must rebuild the water network geometry to conform to the feature-based record schema supported by Hansen. Tees, valves, hydrants, and other miscellaneous point features must be stored as points in the GIS. Pipes must be stored as lines or edges in the GIS. In Hansen, the line features should be identified by "from" and "to" points. In the GIS, points should be "snapped" to the end of lines. There should be a one-to-one relationship of both point and line features in the GIS to their associated records in Hansen. In a pressurized system such as water, flow direction is required to map shut-off valves for breaks or emergencies. Figure 1 is an example of water GIS network geometry.
- Long Term:
  - **Hansen Integration**—The water GIS feature identification numbers (FID) must be wired to the Hansen ID by having a Hansen ID field in the point and line attribute tables. It must be done for all water features with instructions on linking Hansen tables to the correct feature class table. Furthermore, the City must institute GIS-based feature editing for water. New records in Hansen should be initiated by creating new features in the GIS.

    Hansen's GeoAdministrator (a tool currently not use by the City) has a ArcMap utility to assist integration. GeoAdministrator allows a GIS analyst to create a new utility feature (point or line) while automatically initiating a new record in Hansen. It coordinates feature identifiers between the two systems. It also allows the analyst to select and download Hansen attribute fields to the GIS attribute table.

Data Project—Storm/Sewer and Hansen

These two GIS utilities should be integrated with Hansen as separate but nearly identical projects.

Assessment of Completeness

A detailed assessment of areas in the GIS that are missing or incomplete must ensue, especially for storm. Much of the missing information resides in CAD drawings and as-built drawings. Conversion strategies should be outlined. Opportunities to locate features in the field using high-accuracy GPS should be considered. Objectives for data completeness must be reasonable. Not all features require mapping and data management; therefore, efforts should focus on the system features that are most important for maintenance. For example, many sewer service districts only map pipes and fittings for the main lines and exclude lateral service lines on private property. For storm, many cities exclude from their inventory and mapping efforts the multitude of ditches on local roads. Although these ditches require period cleaning, the pipe conveyance network requires far more maintenance as well as asset reporting requirements.

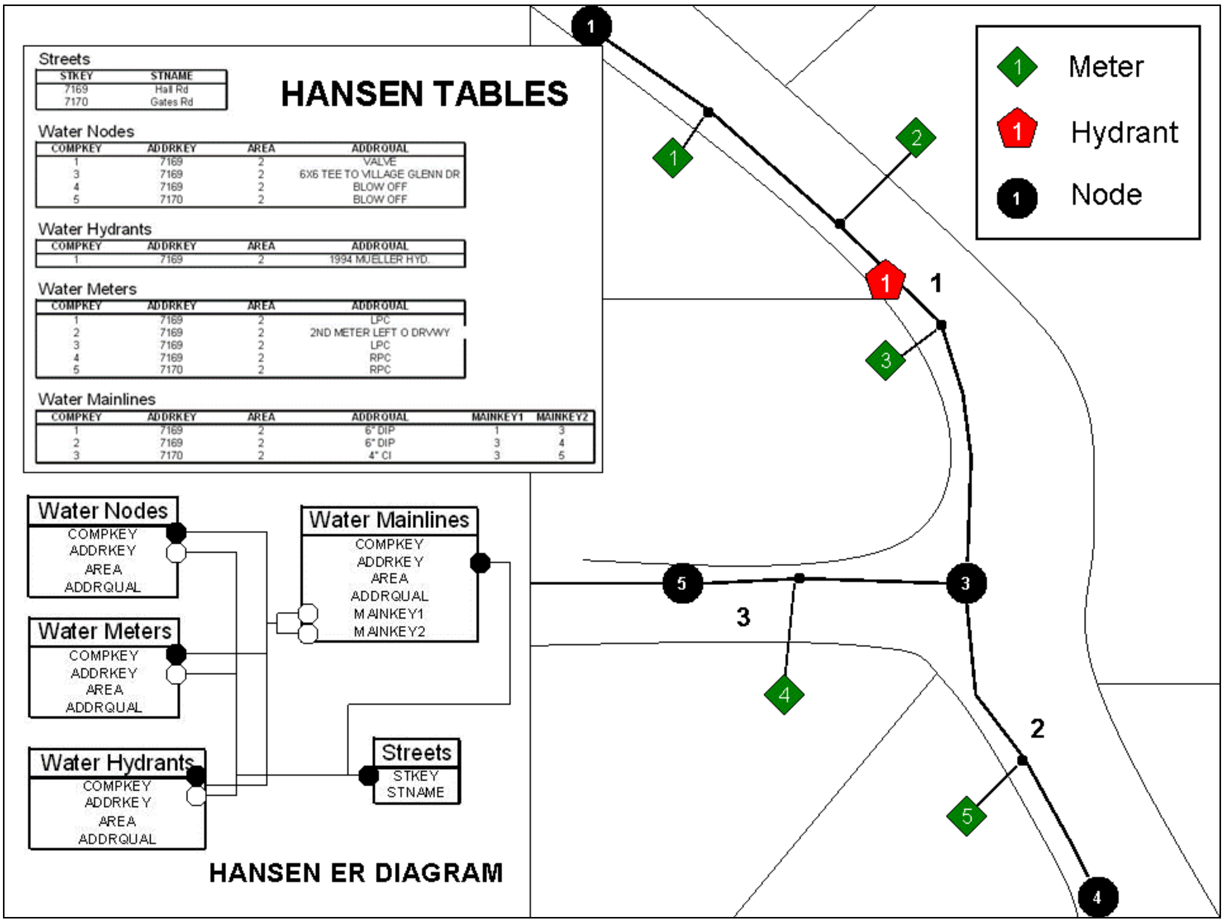

Figure 1. Water GIS Network Geometry

Create GIS Network Geometries

The City must rebuild Network Geometries to conform to the feature-based record schema supported by Hansen. Manholes, catch basins, drain points, outfalls, lift stations, and other miscellaneous point features must be stored as points in the GIS. Pipes, ditches, and other linear conveyance features must be stored as lines or edges in the GIS. In Hansen, the line features should be identified by “from” and “to” points. In the GIS, points should be “snapped” to the end of lines. There should be a one-to-one relationship of both point and line features in the GIS to their associated records in Hansen. In gravity systems, notably storm, invert elevations must be identified to establish flow direction.

Hansen Integration

The GIS feature identification numbers (FID) must be wired to the Hansen ID by having a Hansen ID field in the point and line attribute tables. Although this is already done for some utilities in GIS, it must be done for all with instructions on linking Hansen tables to the correct feature class table. Furthermore, the City must institute GIS-based feature editing for utilities. New records in Hansen should be initiated by creating new features in the GIS.

Hansen’s GeoAdministrator affords opportunities for superior long term integration. It is briefly described in the Hansen Integration task for Water in the preceding section.

Hansen Cleanup

This is no small task but must be done. The Hansen data for all utilities is not complete, inconsistently entered, and poorly coordinated with the associated GIS features. It is recommended that the City conducts geodatabase/geodata model design workshops for these two systems prior to the cleanup. The data model should define the critical system features and attributes. Data value domains should be built that detail the needs for subtypes and system attributes. The Hansen cleanup process should be tailored to support creation of the geodata model for each utility.

The Hansen cleanup effort must engage city staff that work with sewer and storm systems on the ground. These staff know the detailed system components and the required information for maintenance, management, billing, and asset reporting. Functional aspects of system maintenance and management must be considered. This includes pipe and fitting replacement scheduling, asset reporting, work order processing, and hydraulic modeling.

Specifically, the following cleanup duties must be performed:

- Identify required Hansen data fields for each utility feature type (based on Geodata model workshop and GDB design schema).
- Perform a database query on the required fields to isolate records with missing values or inconsistent (“ad hoc”) values. Research for valid codes and correct values and re-enter data.
- Identify features in Hansen that are missing in GIS, and vice versa. Coordinate Hansen records to represent a one-to-one match with GIS feature records. For instance, a single length of sewer main in Hansen is stored as a single record and is terminated at each end by a fitting. In GIS, the same main must be stored as a single polyline with a point at each end representing the fittings. This same sewer main in GIS should not be more than one record, even if there are service line tees that would otherwise section the main in the GIS.

Data Project—Street Network and Hansen

The City’s street network is generally complete. The City does not have to create address ranges on street centerlines for geocoding (already done by Portland Metro). The City must focus its effort on a.) Editing the street network based on projects (new streets, vacated streets, and changes to the network topologies based on new intersections, etc.), b.) Synchronizing the street network with Hansen, and c.) cleanup and management of the Hansen database for streets and street assets.

The City’s street network project should follow the same steps as for utilities, by assessing completeness, creating a street network geometry, integrating with Hansen, and cleaning up existing Hansen data. The preferred Hansen topology for streets are segments terminated on each end by a node (intersection, cul-de-sac, or dead-end). The benefit of adding intersections is that assets can be associated with them (rather than on the segment itself which could be ambiguous, such as a sign at an intersection).

Signs are best associated as an X-Y coordinate and mapped in the GIS. That solves the problem of side-of-street and linear distance along the street segment.

Data Project—Water Meter Mapping and Billing

In general, the Tigard water billing department has a system that works for monitoring the installation and replacement of meters, the reading of meters, and the billing for water use. Springbrook is used to inventory meters and to bill water users in the service area. A project to integrate water metering and billing with GIS should include the following:

Locate the actual meter locations in a GIS. The City already has a manual mapping method of marking meter locations on plat maps; however, there are several meters that are not formally located and are in obscure locations on a property. All meters should be entered into GIS.

The meter data in Hansen should be reviewed against the meter data in Springbrook. Discrepancies should be reconciled. The Springbrook meter ID must match the associated record in Hansen.

The process of entering new and replacement meters in Hansen must be a formalized process. It should directly follow the entry of meter data into Springbrook.

Gaps

The greatest gaps in deploying spatial data projects are cost and time. The GIS Coordinator must be offered support of City staff to complete data projects and/or be able to spend approved money to hire outside assistance. The use of staff time is difficult because of the demand of daily operations and duties.

Strategies

- Each project must be managed. The manager should be well-versed in the technical intricacies of the data models, data dependencies, and relationships to other business systems.
- If the project is deployed internally, the project duties must be integrated with the daily operations of project staff.
- Not all data projects can be done internally. Outside assistance will greatly boost the deployment of the projects. Although the City should perform their own field survey of meter locations (City field staff are most knowledgeable), an effort to coordinate Springbrook, Hansen, and the GIS meter layer should be outsourced because of its complexity and time requirements.

ORGANIZATION AND SUPPORT

The most successful GIS operations in government are supported by a vital organizational structure that is recognized has having equal, or greater, importance than the technology. In smaller organizations, where the needs are great and the staffing is less, attention to the people and the organization is even more critical to success of the GIS. Organization and Support encompasses the areas of roles and responsibilities, governance, and daily operational support for City staff.

Goals

- Provide staff resources to support GIS users at the City with live support, tools, and connections to outside resources.
- Continue support for strong leadership to guide GIS development at the City.
- Maintain a strong team approach to governing GIS, with solid governance.
- Plan and Build the GIS with a systematic approach that takes into account short term and long term needs.
- Build GIS strength in staff within IT and within City departments

Projects and Actions

The City of Tigard has already made a strong start on creating the kind of organizational structure and staffing approach to support GIS in the long run. Departmental leaders have worked together to support the GIS planning and implementation process. City Council has been extremely supportive of this team effort within the City. The following recommendations are designed to move forward from the existing success with a strong organization and support for the long term.

The primary issues in staffing are a lack of clear definition and management of key roles, combined with a need for training at all levels. The GIS Coordinator has worn many hats, as is common among early GIS implementations in smaller organizations. As Tigard moves to a true enterprise implementation, the GIS Coordinator is needed more as a leader, organizer, project manager, and high level technical advisor. The technical roles in system administration, data management, and programming must be filled by additional staff or by assignment and training of other existing staff.

Roles and Responsibilities

The roles and responsibilities involved in ongoing GIS development and management are based on the requirements defined by the City of Tigard, as well as on the experience of other successful government GIS implementations. Regardless of the number of staff, these roles are necessary in an enterprise GIS. Each organization must decide, based on budget and needs, how they will assign the responsibilities in an effective manner. Most importantly, the roles must be clearly understood and assigned. Without the organizational framework, the GIS cannot meet the goals and actions set out by the City of Tigard. The organizational roles and responsibilities suggested for Tigard are listed below, followed by a matrix that builds upon the original matrix in the GIS Strategic Plan by showing additional roles, responsibilities, and service gaps. In some cases, the staffing may be available but the responsibilities are not well defined or managed. This is particularly evident in the area of data maintenance and management. This matrix will focus on what is missing in the current environment vs. what is needed to support the envisioned GIS. An additional diagram later in this document shows the overall GIS framework for the City and how these roles and responsibilities fit within the components of the framework. Note that the list of responsibilities for each role is not exhaustive. These may be refined, as needed, by the City. This key roles and responsibilities are as follows:

GIS Coordinator

The GIS Coordinator role at Tigard is already in place and working very effectively. The primary roles of the GIS Coordinator are to:

- Lead the daily GIS efforts of the City
- Coordinate GIS development efforts, including projects and system architecture, according to a long term vision and plan for GIS
- Manage yearly GIS work planning and budget efforts
- Lead the GIS Steering Committee
- Manage communication regarding the GIS. This includes communication with GIS users, the GIS Steering Committee, Information Technology, outside agencies, and City Council
- Coordinate all roles in the GIS as listed below

Spatial Data Administrator

The Spatial Data Administrator role is spread across the City at this time, with the GIS Coordinator taking the leadership role, to a large extent. With spatial data as the key to the City's GIS, the role of the spatial data administrator is essential. Without a centralized spatial data maintenance function, the administration of the cooperative spatial data effort is very important to the City. This includes managing the data from external agencies, such as Washington County and Portland Metro. The limited staff resources at Tigard, combined with broad GIS use across departments, require that the responsibilities are clearly defined and assigned. In this case, this crucial role must be supported by outstanding data stewardship in the departments. Key responsibilities of the Spatial Data Administrator include:

- Design and manage the Geodatabase environment at the City
- Develop data standards
- Manage and develop metadata
- Coordinate with GIS System Administrator regarding business system data and SDE
- Actively manage GIS data stewardship within the City
- Coordinate data acquisition from external agencies, including interagency agreements
- Coordinate requests from internal staff for data from external agencies, including decisions whether or not to add external data to the City's Geodatabase

Hansen Administrator

The City is in the process of hiring a Hansen Administrator. With the extensive use of Hansen as the repository for data regarding utility assets, the role of the Hansen Administrator is critical. With the requirements for tying Hansen asset data to GIS features, the role is increasingly important. The responsibilities of this position, with regard to GIS, will include:

- Coordinate and ensure maintenance of Hansen data
- Work with Spatial Data Administrator to develop linkages and processes for Hansen/GIS data entry and management
- Manage Hansen data verification
- Work with Spatial Data Administrator, GIS System Administrator, and GIS Coordinator to define a plan for Hansen/GIS development, integration, and management

GIS System Administrator

The system administrator is in charge of the overall system architecture and administration of GIS software and technologies. Currently the GIS Coordinator is filling the primary responsibilities of this role. As the system grows, it will be necessary to balance this effort among other staff in Information Technology or to create a position to handle this challenging role. Responsibilities include:

- Work with GIS coordinator to develop overall system architecture for GIS
- Coordinate software purchases and manage ESRI licensing and maintenance payments
- Manage and maintain SDE
- Manage and maintain GIS, database, and business system connections
- Manage and support GIS system performance

GIS Developer

Most GIS development applications will be contracted to outside consultants. The GIS Coordinator manages these efforts. If hired, a Lead GIS Analyst and the System Administrator would also work closely to ensure that the work meets City standards for software, architecture, quality and long term maintenance. The role of a GIS developer is to develop applications as determined by the City's work plan.

Lead GIS Analyst

This role is currently being filled by a number of City staff, including the GIS Coordinator and GIS "power users", as well as by external consultants. The role is needed as applications are developed, whether internally or externally, to ensure that development meets business needs of the users through good design. Ideally, a staff position in Information Technology would fill this role. Responsibilities include:

- Conduct or manage analysis projects for departments with no GIS analyst
- Support Departmental GIS Analysts
- Coordinate with other business analysts in Information Technology
- Develop user business requirements for projects and applications
- Create standards for GIS project development
- Develop functional design for GIS applications and tools
- Guide outside contract work in the areas of business requirements and development
- Work cooperatively with GIS Developers (internal or external)

Departmental GIS Analysts

Tigard already has some excellent GIS analyst resources in the City. With limited GIS staffing in Information Technology, these roles are very important. Departmental GIS Analysts play a very large part in the GIS at Tigard. Their lead roles should be formally recognized and their work should be well supported by the GIS Coordinator and, ideally, a lead GIS Business Analyst. Their responsibilities include:

- Conduct GIS analysis for their departments
- Work together on joint departmental GIS projects
- Develop and collect GIS project data for their departments
- Work with Departmental Data Steward (in some cases the same person) to coordinate data addition to Central GIS Data Repository, as needed
- Act as lead liaison and spokesperson for their department in City GIS efforts
- Support less technical GIS users within their departments, including coordination of external support for development or analysis that they do not have the time or expertise to undertake

Departmental Spatial Data Stewards

The City of Tigard, along with many other cities, does not have a centralized data maintenance function. The City's base map and shared departmental GIS data are pulled together from external and departmental sources. The work is managed by the role of the Spatial Data Administrator, who will need to, in many cases, coordinate with the Hansen Administrator. The departmental data stewards must be clearly identified and so must the data and processes that will support their work. Their responsibility is to maintain specific departmental spatial data that is part of the City's corporate Geodatabase environment.

Summary

Figure 2 summarizes the roles and responsibilities involved in ongoing GIS development and management.

GIS Roles and Responsibilities – Requirements and Gaps								
Responsibilities	**Lead Staff Roles**							
	GIS Coordinator	**Spatial Data Administrator**	**Hansen Administrator**	**GIS System Administrator**	**GIS Developer**	**Lead GIS Analyst**	**Dept. GIS Analyst**	**Dept. Data Steward**
Leadership of the GIS effort; coordination and development of GIS roles, responsibilities and guidelines, development and management of work plan, Citywide, interagency project management,	●							
Spatial Data Integration Planning, Implementation, Management		●						
Hansen Data Management and Integration			●					
Geodatabase Administration, Data Standards, Metadata, Data Guidelines for Dept's, Central data repository management				●				
Application Development					●			
Analysis for departments without analysts, City-wide project work, Dept. Support						●		
Analysis, departmental GIS planning, coordination with City GIS effort, departmental GIS support, GIS projects							●	
Spatial data maintenance, Hansen data maintenance								●

● Lead Staff Roles and Responsibilities | Areas of Highest Concern | Areas where GIS Coordinator is filling role that needs more support

Figure 2. GIS Roles and Responsibilities

Training

The importance of training is always seen as critical to GIS success, particularly with the complexity of GIS software and the ongoing technological advances in GIS. It appears that consultants, managers, and staff all agree on the importance of training, yet somehow the training budgets continue to be minimal in most GIS implementations, particularly after the early stages of building the GIS. A training plan is needed and should be updated annually. The GIS work program needs to identify the training needed at all levels, both novice and technical. Our experience shows that most mature GIS implementations falter as training levels fall. The primary frustration of GIS users, particularly at the novice level, is the lack of even the most basic training about the tools and resources available to them in GIS.

Governance

Governance is the ongoing planning, decision making, and surrounding organizational structure that will ensure GIS development is supported at every level of the agency, from staff up to City Council. This will ensure that business needs for GIS are supported by appropriate projects and budgets. The structure is largely in place at Tigard. This recommendation is primarily focused on encouraging the City to stay with this structure for the future of the GIS, not just in the early building phases. The basic structure includes the following four components:

Steering Committee

The GIS Coordinator leads a Steering Committee that represents departmental interests. The members are at a level in their department that allows excellent communication between the departmental business interests, including staff level and higher level management. The existing level of effort and participation is excellent; it requires consistent attention and tweaking, as needed, over time.

Technical Working Groups

Technical Working Groups are an excellent way to use the City's GIS analyst resource base to work on special projects and problems. The Steering Committee will work together with the GIS Coordinator to define the projects and issues that might be best suited to this type of approach. A larger agency might have an ongoing "GIS Technical Committee". At Tigard, the Steering Committee already contains the most technical GIS analysts at the City and an additional ongoing committee would add overhead, but little value, to the City's GIS effort.

Department Leadership

The Steering Committee staff must keep their departmental managers informed. The Department Leadership has provided invaluable support for GIS thus far. They have indicated their recognition that their leadership is crucial to the GIS effort, particularly in the area of the business process changes required for data management; system integration; and optimized work and data flow. The primary recommendation here is, as with governance overall, is to be conscious of the importance of this kind of leadership over time and to continue with this approach.

City Council

City Council makes the final budget decisions. The governance structure outlined here, combined with business focused GIS work planning, will ensure that they can make informed decisions that are framed by a clear understanding of how GIS fits with the City's priorities and daily business.

Communication

Communication is singled out as a separate organizational consideration because communication and coordination impact every aspect of the management and support of GIS. The following aspects of communication are most important:

- Communication between the GIS Coordinator both up and down the organization
- Communication at the non-technical GIS level, so that staff understands what GIS is, how it works in the City, and what it can do for them
- Communication between the different governing bodies
- Communication and coordination among all the roles within the GIS, particularly the understanding of those roles and the responsibilities within them
- Active communication of GIS status and success, including demonstrations, presentations, grants, and awards. This is a popular strategy in the early development phases of a GIS but is often lost in the long term implementation. Ongoing understanding of the benefits and concrete results of the GIS investment ensures budget support in the long run. It cannot be viewed as a "nice to have, but not necessary" activity. Departments can work together to support this effort.

Gaps

As stated earlier, Tigard has started building an excellent foundation within the organization for long term support of GIS development and management. There are some gaps between the desired future for GIS and the organization required to support it. The following areas of concern, which have also been referenced above, need to be understood and addressed as needs are balanced against resources:

- Staffing and Resources—As expressed throughout the recommendations, Tigard desires to create and manage an enterprise GIS with limited staffing resources. An enterprise effort requires a certain base level of roles and responsibilities, regardless of the agency size. The current staff level is barely enough to meet the most basic level of service. It cannot sustain the level of system and work integration that Tigard envisions, particularly in the area of spatial data management and analyst support.
- Training—The training levels have not been assessed or defined

Strategies

There are a few key strategies that might assist in creating the organization and support to achieve Tigard's GIS vision:

- The organization is as critical to GIS as the technology
- Align resource planning with GIS vision and development, every step of the way
- Add resources at the technical and system administration level to lighten the technical load on the GIS Coordinator position, in order to foster adequate attention on the leadership and management of the City's GIS.
- Build a conscious team approach that accommodates limited staff resources
- Recognize training as part of the Total Cost of Ownership (TCO) of the GIS
- Build additional strength through the use of outside resources, but manage them within a clear framework of roles and responsibilities
- Success is achieved through good leadership. This will be seen in the GIS effort.
- GIS development will be strengthened by creative and focused communication

APPLICATIONS AND TOOLS

Applications and tools focus on desktop productivity for the City staff. The existing research and mapping tool, MAGIC, needs to be replaced with more modern and scaleable technology. There is also a tremendous business need across the City for access to current asset, planning, and other business information. Existing business systems and GIS need to interact in order to provide the most efficient means of updating and accessing the City's spatial information.

Goals

The vision for GIS applications and tools can be refined into specific business goals. The top priorities identified by the City staff are:

- Provide direct staff access to the high quality spatial information needed to support the research needs of daily City business, such as utility/infrastructure maintenance and repair, permitting, planning, service requests, billing, crime analysis, questions from the public, and many others.

- Make GIS easy to use for the average staff person, by providing an excellent user interface; standard data and tools; and mapmaking capabilities.
- Optimize the investment in business systems, such as Hansen, Springbrook, and PermitPlan (Accela) by integration with GIS.
- Extend the use of GIS into the field for use in inspections, service calls, maintenance work, and other field operations.
- Support specialized departmental needs with needed GIS applications.

Projects and Actions

There are several key projects that will bring GIS to the staff at the City of Tigard more effectively and seamlessly. These high priority projects are focused on the access to GIS, as well as the data management and integration of existing business systems with GIS.

MAGIC Replacement

This project has already been identified as a top business priority for the City. The funding is available in 2007 for application design and in 2008 for development. Aside from the spatial data management effort, this is the single most important investment that the City will make in GIS. Without good access for the average user, the GIS will not achieve its full potential and value. It is important to realize that this application will last a very long time. Good design and maintenance are critical to its success. The following approach and actions are recommended:

- This application must fully replace MAGIC with replication of existing functionality and also improvement of the application. The value of MAGIC in supporting City staff cannot be underestimated. Every business area in the City relies heavily on this tool for their spatial data access. If MAGIC cannot be unplugged, then the new application has failed.
- Conduct a thorough design process that selects the best features of MAGIC, while improving access with the new spatial data management features of ArcGIS.
- Create a MAGIC replacement project team of users to assist with detailed requirements, review of the design, and testing.
- This tool must be developed within an overall development strategy for GIS architecture. See the “System Architecture” discussion for more details on the need to create tools within an architectural framework.
- Develop a layering scheme for spatial data management that supports this application. This must be done before implementation and should be tied in with the design process.
- Even with an excellent design, there is a need to focus very consciously on the maintenance of this application. Determine how it will be supported, who will maintain it, and create a maintenance budget and plan. With MAGIC, the maintenance was very ad hoc, resulting in a cumbersome tool that cannot easily be migrated to another technology.

Hansen Integration Tools for Data Management

The Hansen business system is the preferred data entry mechanism for utility information at the City. It ties in directly with the business operations of the utilities. The need to integrate the spatial data in Hansen with features in the GIS has already been recognized and some preliminary work has been done to connect feature IDs in the GIS and Hansen. The “System Architecture” and “Spatial Data Management” sections deal with some specific recommendations on Hansen integration. This section focuses specifically on the Hansen tools that allow GIS and Hansen to work together more effectively for coordinated data management. The following approach and actions are recommended:

- The definition of roles and responsibilities in data management is key to Hansen integration at the spatial data level. See the "Organization and Support" and "Spatial Data Management" sections for further discussion.
- Obtain an evaluation copy of the Hansen GeoAdministrator application. This tool is designed to streamline the administration of spatial data between Hansen and ArcGIS. The tool allows for data entry into Hansen from the GIS environment and also provides excellent tools for checking the concurrency between the GIS and Hansen data.
- Develop a GeoAdministrator test project to determine whether the GeoAdministrator tool can work for the City. The appropriate GIS and business staff, including the new Hansen Administrator and the GIS Coordinator, should participate in the evaluation of this product. The City of Lake Oswego is an excellent resource for demonstrating the tool and showing how it can be used effectively for integration of Hansen and GIS at the data management level.
- Training will be needed to support this level of Hansen integration. Direct work with a Hansen representative who can train while demonstrating the capabilities would be an excellent addition to the GeoAdministrator test project. We have seen both success and failure with this tool at different cities. The primary reason for failure is a lack of understanding of how the tool links Hansen records to the GIS feature attribute table. It is recommended that training focuses on 1.) the GIS network geometry required to perform the integration, 2.) the use of GeoAdministrator to edit existing network features and create new features, 3.) the use of GeoAdministrator to help synchronize the GIS and Hansen tables, and 4.) the use of GeoAdministrator to merge Hansen attributes to the GIS layer.
- Long term issues are implementation and management of the GeoAdministrator tool and processes. If the City chooses to use this tool, the Hansen Administrator and GIS Coordinator need to develop the roles and responsibilities for the use and management of the tool. Ongoing, the tool must be considered as new data sets and business processes for Hansen come into the City.
- Although integration tools are built into GeoAdministrator, there are fundamental inconsistencies in the attribution and construction of features in Hansen and GIS features that will require a tailored reconciliation approach. Custom reconciliation procedures will compare attributes in a Hansen record against its counterpart in GIS. Programmed rules will correct attributes to comply with domains and subtypes in the Geodatabase. Furthermore, an automated procedure to join the Hansen attribute tables to the GIS attribute table will promote efficiency.

Integration with other Business Systems

This effort is primarily discussed in "System Architecture". The relevance to applications and tools is to clearly recognize that business systems may, or may not, have a GIS interface. Research is needed to evaluate the applications available and assess those against staff needs for access. There may not be an easy way to move between GIS and business systems such as Springbrook and Accela, for example. The ideal viewer application (see "MAGIC Viewer Replacement" above) will "live link" the most important data fields in these external applications to the GIS features. Management of the permit and meter data will remain in their external business system, but map viewing will be enabled via the GIS Viewer. A procedure for initiating this live link to Springbrook and Accela may require development in the GIS Viewer. Furthermore, GIS should be part of the requirements process for any new business systems.

GIS in the Field

This need for broad GIS access at the City was discussed in the requirements interviews. Better access to GIS in the field is desired by field staff doing inspections, maintenance, and building projects. At this time, information for field personnel is available via searching several documents (mostly on paper and microfiche). However, the potential for data collection and use in the field should be considered in design and integration efforts so that this is planned for in the long term, perhaps several years out.

Integration with Springbrook and Tidemark (Accela)

Applications should be built to map information from these systems using a GIS viewer.

Document Management and GIS

The City is moving forward with purchasing and implementing a city-wide document management system (DMS). There is a strong desire to be able to integrate GIS with a DMS to tie documents to a location and thus view a location and its associated documents, or search documents and view its associated location. It is recommended that access to documents be as seamless as possible for the end-user (i.e., fewest amount of clicks) and be accessible via the GIS or via the DMS. One potential usage identified during the needs assessment was being able to tie historic photos in the Library to a map environment. This could serve as a good test project for DMS and GIS.

GIS Portal

One of the goals of the enterprise GIS is ease of access. Given the robustness of the planned system, it is recommended that a GIS Portal, or front-end be developed in order to create a 'one-stop shopping' entry for users accessing spatial data. A portal should offer access to the main enterprise applications, specific applications, a common query entry, links to other GIS related sites, training links, FAQS, links to metadata, help, etc.

Public Access to GIS

Using the similar concept mentioned above, the City should develop a similar single point of entry for spatial data with data available for the public. Ease of access is even more important for any public portal given the likelihood of casual users. The City has already developed a pilot project being used by the public, CRIME Spotter, which can serve as a basis for further development Other elements identified in the GIS Portal above can also be used in the public access portal.

Police Command and Patrol

The City's Police Department must align itself with technology innovations in homeland security and public safety. Although successfully using in-vehicle navigational maps from Portland Police, there are several opportunities to improve map detail and geocoding using the City's GIS layers. By using the City's parcel, street, address, and aerial photo layers, in-vehicle maps will provide more local detail for responding officers and offer avenues for more efficient response to 911 calls from cell phones. Recent technologies in wireless map services should be investigated. Stationary GIS map engines can render "live maps," including officer and call locations at regular brief time intervals (10 to 20 seconds) and serve them wirelessly to vehicles. There are consulting firms that specialize in GIS-based command and control systems.

Crime Analysis

The City's Police Department relies on PPDS data and CAMIN2 for reporting and querying on crime statistics. The data and application are not within the control of the City. PD needs additional custom querying capabilities, those directly access the database (PPDS, CAD) and pass the X-Y coordinates to a map. Some of these include: 1) typing a single case number, or multiple case numbers and having them display on a map, 2) accessing stolen property codes in order to display on stolen crime patterns on a map 3) mapping CAD data, and 4) specialized custom queries that allow for key word searches within the database.

Gaps

This identification of gaps between the existing situation and desired outcomes represents the most significant issues facing successful implementation of GIS tools and applications. These gaps show the areas of concern that impact the application projects and actions outlined in the recommendations. The most important are as follows:

- MAGIC—This application has worked for many years and is the most widely used application for GIS at the City. A complete replacement of this application is a major undertaking. The effort will include a design "from scratch," including a design workshop and detailed technical specifications.
- Technology—Technology changes have been incredible in the last few years of GIS, particularly within ESRI software. The changes are still, to some extent, a moving target. ESRI is moving toward ArcServer as a development platform. Tigard should look carefully at ESRI recommended development platforms in the new application and system architecture design project.
- Staffing—GIS application development requires in-house roles and skills in business analysis, programming, and management—even if the applications are developed by outside vendors. The City must consider building additional strength in this area.
- Hansen—The City needs staff to support for integration, data management. The proposed Hansen Administrator is an important step in this direction.
- Training—There has been a lack of training in GIS overall in the past. This is a vital component of GIS success at Tigard, particularly as people are faced with new technology and applications.
- Roles and Responsibilities—These have not been clearly defined in the past. This issue is addressed in more detail under *Organization and Support*, as well as *Spatial Data Management*.
- GIS in the Field—There is a large gap between the current field use of GIS and mapping and the implementation of technology solutions

Strategies

The following strategies are suggested as guides for the implementation of GIS applications and tools at Tigard:

- Work with other agencies, such as Washington County and nearby cities, such as Hillsboro, to optimize investment in applications such as the MAGIC replacement
- Support business system integration by using daily work and business systems, such as Hansen, Springbrook and PermitPlan (Accela) as primary spatial data repositories, where possible. Reduce redundancy regarding specialized GIS data entry.
- Include annual application maintenance in the application design and implementation.

- Support new applications and tools with adequate, ongoing training at all levels. Acknowledge training as part of the TCO (Total Cost of Ownership) for software and applications.
- Develop in-house capabilities to manage and support application development and maintenance for GIS, especially those that support flexibility in developing query and reporting customization from business systems.

SYSTEM ARCHITECTURE

The GIS system architecture must be designed to support spatial data use; organization and communication; and applications and tools. The system architecture must consider: a.) IT level hardware, software, and network components to support distribution of data and applications, b.) an enterprise database, c.) a middle-tier for serving spatial data, d.) methods and components for connecting business systems, and e.) securities, authentication procedures, and protocols for managing data. At this time, the City has a functional IT infrastructure and enterprise database (SQL Server 2005). They are using ArcSDE and three enterprise Geodatabases (Portland Metro GDB, Tigard corporate GDB, or "TIG," and an image catalog GDB). The City's IT Department is currently working on a secure authentication system for enabling data editing by "power users." The goals and recommendations in this section focus on connecting business systems and the opportunities in supporting GIS applications via Geodatabase.

An industry term the City must associate with is Service-Oriented Architecture (SOA) in approaching their enterprise GIS. SOA is an approach that supports heterogeneous, loosely coupled services and is a vehicle for integrating GIS tools into the overall IT architecture.

It is important to note that the City is deploying a separate project for designing GIS architecture and GIS applications. Recommendations in this document will remain very general and will be designed to initiate this project.

Goals

- Centrally manage the GIS using a GIS Systems Administrator
- Create and manage a system that supports the deployment of GIS data via a Geodatabase. The Geodatabase will be secure and allow designated power users the ability to manage and maintain enterprise data sets.
- Spatially enable business systems, notably Tidemark, Springbrook, and Hansen, using GIS components and tools.
- Build the enterprise GIS using industry standard components and features to a.) Allow for direct support by vendors and consultants, b.) Offer an easy way for the City to manage the system, and c.) Optimize long term investment in the tools and technology
- Manage and develop GIS architecture in conformance with City IT architecture

Projects and Actions

System Architecture Design

This project, scheduled for completion in fall 2007, should include the following design elements.

- **Administrator's User Interface**—The interface must allow the GIS System Administrator to manage GIS user accounts including restricted read/write access to enterprise GIS layers in the Geodatabase. The Administrator's interface should allow for monitoring regular use and layer versioning (check-in and check-out activities). The interface should allow the GIS

System Administrator to audit system performance as well as monitor data synchronization of GIS and external business systems (notably Hansen and GIS). The interface should also allow the GIS System Administrator automated processes for importing Portland Metro data into the City's Geodatabase and prospective data viewer system.

- **Applications Development and Management Methods**—Because the City has committed to ESRI-based enterprise applications (notably ArcSDE and Geodatabase), applications should comply with the service-oriented architecture (SOA) methods outlined by ESRI. Development platforms should be based in ArcObjects and should be deployed from ArcGIS Desktop and/or ArcGIS Server. ESRI has recommended four development environments for applications (Java, .NET, cross-platform C++, and COM). The City should align themselves within these development environments for the best possible technical support from ESRI and consultant Business Partners.
- **Interoperability with Business Systems**—This may be a complicated design element. It is important to define the data reconciliation process in parallel with application and system architecture design. There will be favorable data constructs discovered during the application and system architecture design process. The system architecture must support a method of connecting the business systems seamlessly via GIS. The connection must be real-time, or virtually live via a nightly data warehousing process. However, prior to actual deployment of the system, the data reconciliation projects must be completed.

Gaps

At this time, the City has made formative steps toward developing robust system architecture. The City has invested in the core ESRI technologies that support an enterprise GIS. The only gap is the inherent challenge of integrating business systems that have weak vendor-supported GIS integration. Although Hansen has offered Clients various GIS integration tools, the other vendors generally have not. These challenges are not insurmountable; however, require a concerted effort by the City to develop integration solutions.

An example is addressing. All of the business systems rely upon addressing; however they differ in the way an address is parsed in their database. How does the City reconcile these addresses for easy consumption into the spatial (GIS) environment? A creative response should include alternate opportunities for spatially locating features (notably X-Y coordinates); albeit, not a normal locating method for most business systems.

Strategies

- Leadership for system architecture design projects must come from a very high level. The GIS Coordinator must spearhead these efforts in the context of serving the larger user group.
- Vendor engagement is critical. The City must choose system architectures and application design strategies that are directly supported by their vendors, notably Microsoft and ESRI.
- Where possible, locate features using the power of GIS, rather than by addresses or other location descriptions. GIS feature geometries do not rely on conventional location methodologies. They store points, lines, and polygons in coordinate reference systems using binary code and are drawn magically to a map via enterprise GIS applications and data viewer components. These storage and mapping mechanisms have benefits over street addressing and legal descriptions by bypassing common data entry and database coding errors. The GIS should be more relied upon for locating features than addresses.

SUMMARY

In summary, a few key points and conclusions are emphasized. First, courses of actions must follow a logical process to form a successful implementation plan:

1. Fix, modify, enhance, and/or redevelop GIS data per recommendations for Spatial Data.
2. Establish a system of governance that supports stewardship of DATA. Key staff should be put in charge of data maintenance/management. Create data management protocols.
3. Create a Geodatabase and System Architecture that is designed to house the City's data and directly supports the City's business areas. The design for this will be the final task for Phase 2 of the GIS Strategic Plan (System Architecture and Applications Design).
4. Build applications that allow for regular maintenance of data, allow for daily data viewing and mapping, and operate in the system architecture as designed in the System Architecture and Applications Design project (forthcoming).

In addition, within the four above steps are some notable observations and conclusions:

- Creation of the master address table in Tidemark to feed the GIS point address layer, Hansen (where appropriate), Springbrook, and other business processes (for example, Crime Spotter, geocoding, and mailing systems) is a data project that will benefit nearly ALL business areas and City Departments.
- Utility network/Hansen makeovers for water, storm, and sewer will cure a long-standing pain point with the Public Works Department. It will directly support effective management of assets and creation of work orders.
- Good data and management of the data is everything. Success of the System Architecture and GIS applications depends entirely on the data project and data management recommendations.
- Data management will not work without effective leadership, governance over the City's GIS, and the dedicated effort of data stewards.
- Once data governance and stewardship is established the System Architecture is a relatively simple implementation step.
- Applications using new thin map services should come "out of the box" with cartographic and functional enhancements that MAGIC cannot provide. Once customized, this application will be a powerful tool that is used as much or more than the current citywide GIS viewer.

CHAPTER 3.
GIS FRAMEWORK DIAGRAM

Figure 3 shows how the elements of the recommendations fit together and how the roles and responsibilities tie in with the tasks in each area. The GIS Framework part of the diagram, on the left side of the page, shows the components of an enterprise GIS. Everything is tied together and supports the GIS business needs of the City. Governance is at the top, as the oversight and management setting direction in the other components. Spatial data is the bottom, providing a foundation for GIS success. On the right, in matching colors to the GIS Framework circle, is a summary of the roles and responsibilities in each area. The lead role for each area is listed first and highlighted in bold type. Note that not all the roles are yet tied to staff positions. These are the roles that must be assigned and understood, regardless of whether they are within one, or several, positions. The roles and responsibilities ensure that the supporting tasks will be undertaken in each area. The *Organization and Support* discussion in this document provides more details on the roles and responsibilities. Each area of recommendations addresses an element of this diagram.

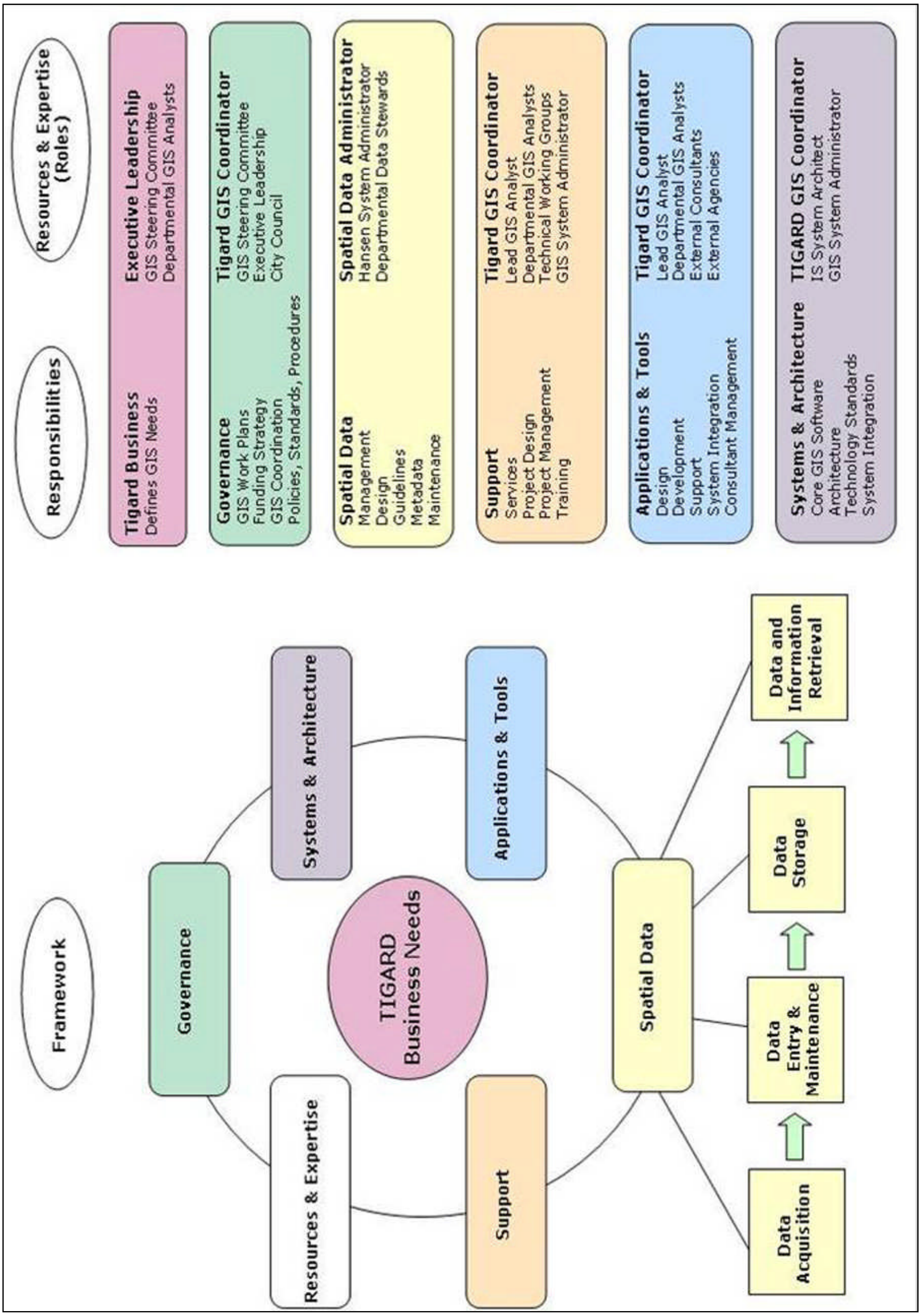

Figure 3. Tigard GIS Framework